

Final Technical Report on NCC 2-776:
Detection and Analysis of Aircraft-Produced Particles in the Stratosphere During the Stratospheric,
Photochemistry Aerosol and Dynamics Expedition

Report Covering Time Period:
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Objectives of the Cooperative Agreement

The objectives of the work funded by this cooperative agreement were to utilize three instruments to study particles in the stratosphere. The first instrument is a dual channel condensation nucleus counter (ER-2 CNC II). The ER-2 CNC II detects particles larger than 0.008 μm in diameter. One channel of the dual channel instrument operates normally, counting all particles which reach the instrument. The second channel provides for heating of the sample so that the number of particles which survive heating to various temperatures can be counted. The second instrument is an aerosol sampler capable of capturing small particles (MACS).

Table 1. MACS Impactor Cut Points as a function of Ambient pressure.

<u>Ambient Pressure</u>	<u>Impactor Cut Point</u>
350 mb	0.064 μm
222 mb	0.042 μm
135 mb	0.031 μm
94 mb	0.021 μm
77 mb	0.018 μm

The third instrument, the Focused Cavity Aerosol Spectrometer (FCAS) provides size distributions of particles in the diameter range from 0.08 to 2 μm .

The instruments were flown on NASA ER-2 aircraft in the Stratospheric, Photochemistry Aerosol and Dynamics Expedition (SPADE) of fall of 1992 and spring of 1993. The main objectives of these flights included characterizing the impact of heterogeneous reactions on ozone destroying radicals in mid-latitudes and, if possible, characterizing sampling of particles emitted by aircraft. It is well known that ozone is destroyed at mid-latitudes in cycles involving chlorine radicals such as ClO, NO and NO₂ and HO and HO₂. It was suspected, prior to SPADE, that the hydrolysis of N₂O₅ on the surface of sulfate aerosol would affect the populations of ClO, NO, NO₂ and HO₂. Testing this hypothesis required knowledge of the composition of the stratospheric aerosol and quantification of the surface area present. The second objective was met, in part, by the two channel CNC as a result of measurements made in the ER-2 plume.

Accomplishments during this Cooperative Agreement

The SPADE Mission produced dramatic results which have been published in the literature. In two papers by Salawitch (1994), it was demonstrated that the populations of HOx, Clx and NOx species are strongly affected by the amount of aerosol surface present. These papers utilized the FCAS measurements and demonstrated the ability to quantitatively predict species important to ozone loss. Sheridan et al., (1994) described the composition of particles sampled by the MACS and described the gradient in composition across the tropopause.

Measurements made in the ER-2 plume (Fahey et al., 1995) suggested that this engine is not a large source of particles. They stand in stark contrast to measurements made in a Concorde plume in 1994 (Fahey et al., 1995). These later measurements demonstrate that the impact of particles emitted by stratospheric must be considered in assessing the environmental impact of these planes.

Data acquired in SPADE were also used in the continuing characterization of the evolution of the stratospheric aerosol following the eruption of Mt. Pinatubo (Brock et al., 1993, Jonsson et al., 1996) and in identifying a source of small particles near the tropical tropopause (Brock et al., 1995).

Conclusions. The objectives of the cooperative agreement were met by the use of the ER-2 CNC II, MACS and FCAS in SPADE and the publication of significant scientific results.

Bibliography.

The publications listed below made use of data acquired in SPADE with the support of this cooperative agreement. The authors include one or more member of the Aerosol Research Group at the University of Denver who were supported on this agreement.

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